WTX-596454/55/56-70-ES-35

250 to 400 Watt, C-Band

High Power Transmitter Module

Operation and Maintenance Manual

Agile
Responsive
Committed

mitec

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Mitec Telecom Inc.

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OPERATION AND MAINTENANCE MANUAL	Preliminary ☒	Released ☐

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Designer: S. Zhou Date: 5 July 06		**REV 0**
Technical Writer: C. Strunga Date: 5 July 06	**DOCUMENT NO. 211603-001MA**	**PAGE 1 OF 35**

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Preface

Scope

This document covers the installation, operation, and maintenance of the WTX-596454/55/56-70-ES-35 250-400 Watt C Band High Power Transmitter Modules. It contains information intended for engineers, technicians and operators working with the transmitter module.

To make inquiries, or to report errors of fact or omission in this document, please contact **Mitec Telecom Inc**. at (514) 694-9000.

IMPORTANT

Important information concerning the operation and care of this product, as well as safety of authorized operators is highlighted throughout this document by one of the following labels:

NOTE

Indicates a reminder, a special consideration, or additional information that is important to know.

CAUTION!

Identifies situations that have the potential to cause equipment damage.

WARNING!!

Identifies hazardous situations that have the potential to cause equipment damage as well as serious personal injury.

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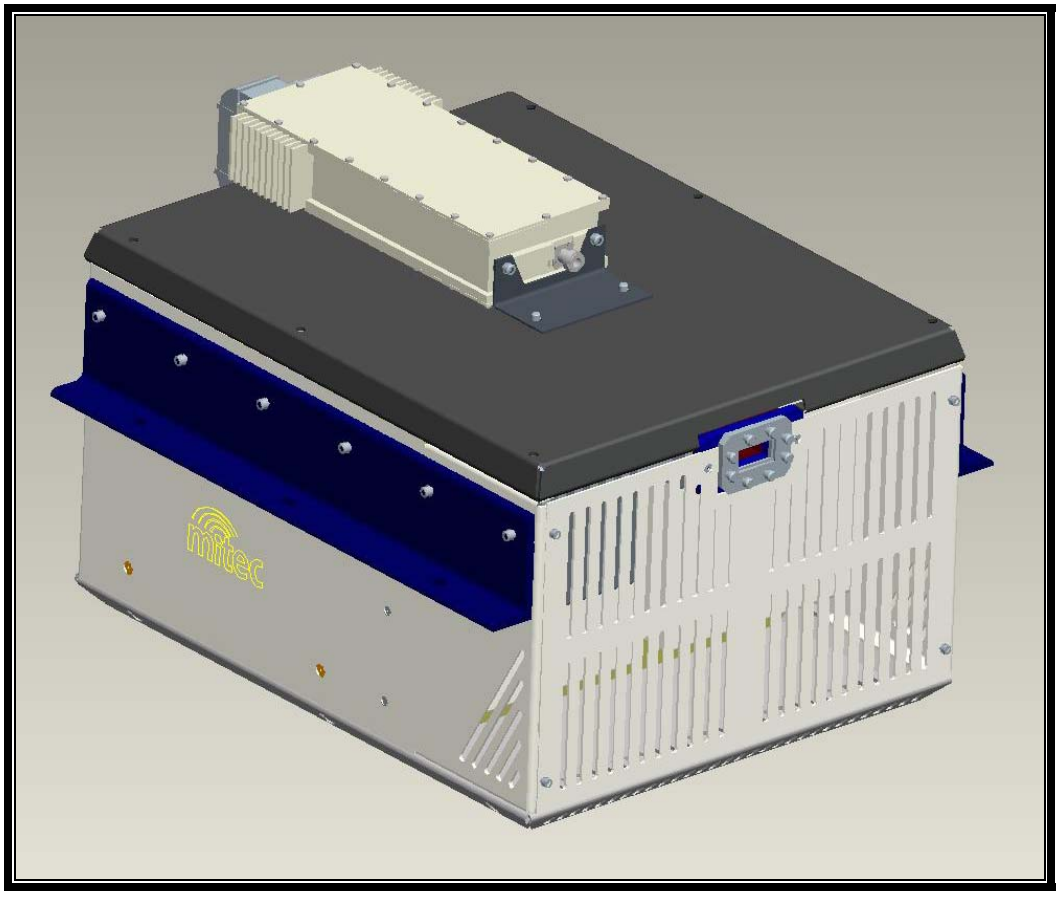
1 Introduction

The High Power Transmitter modules are reliable, high quality, cost efficient High Power Transmitter systems designed for use in VSAT applications. This line of superior products, engineered using state of the art technology, is characterized by unparalleled durability and dependability. The systems also have high linearity and system gain stability over the full operating temperature range. The output operating frequency range is the standard C-Band of 5.850 GHz to 6.425 GHz. However, the operating frequency range can be altered to suite the customer's specification. Refer to Table 1.

Depicted below is the standard C-Band frequency model.



1.1 Receiving and Inspection

The transmitter module is designed to function outdoors and will arrive in standard shipping containers. Immediately upon receipt of the transmitter module, check the Bill of Lading against the actual equipment you have received. Inspect the shipping containers exteriors for visible damage incurred during shipping.

CAUTION!

Handle the transmitter module with extreme care. Excessive shock may damage transmitter module's delicate internal components.

NOTE

Before unpacking the shipping containers, move them near to the site where the system will be mounted. Ensure that the containers are oriented correctly in accordance with the "This Side UP "labels. Carefully remove the transmitter module and packing material from the shipping containers.

Using the supplied packing list, verify that all items have been received and undamaged during shipment. Verify that all items are complete. If there are any omissions or evidence of improper packaging, please notify **mitec telecom inc.** immediately.

1.1.1 Equipment Damage or Loss

Mitec Telecom Inc. is not responsible for damage or loss of equipment during transit. For further information, contact the responsible transport carrier.

When declaring equipment as damaged during transit, preserve the original shipping cartons to facilitate inspection reporting.

1.1.2 Return of Equipment

When returning equipment to **mitec** for repair or replacement:

1. Identify, in writing, the condition of the equipment,
2. Refer to the sales order, Purchase Order and the date the equipment was received.

Notify **Mitec** Sales Administration Department of the equipment condition and obtain a Return Material Authorization (RMA) number and shipping instructions. Mitec will pay for the cost of shipping the product to the customer after the repairs are completed.

NOTE

Do not return any equipment without an RMA number. *This is important for prompt, efficient handling of the returned equipment and of the associated complaint.*

1.2 Preparing for Installation

Before attempting to install or use the transmitter module, we recommend that you first familiarize yourself with the product by reading through this manual. Understanding the operation of the system will reduce the possibility of incorrect installation, thereby causing damage or injury to yourself or others.

*The transmitter module **must** be installed in accordance with the conditions and recommendations contained in the following sections.*

When you are ready to begin your installation, use the information in Chapter 2 (Installation) as a guide for making all the required electrical connections.

1.2.1 Safety Precautions

Carelessness or mishandling of the transmitter module may damage the unit causing serious injury to yourself or others. Please adhere to the following:

WARNING!!

This unit is equipped with an AC power cord and plug. Do not tamper with, or attempt to reconfigure, the cord or plug supplied with the unit, as this can:

- *result in personal injury*
- *void the warranty*
- *cause damage to the units or related equipment.*

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2 Installation & Overview

2.1 General Description

This section describes the installation and theory of operation of the transmitter module.

The module is a stand-alone Transmitter System powered from 24 VDC and 110/220 VAC power sources. It will amplify an input signal from an L-Band RF source up to a power level of 250 - 400 Watts CW in C-Band.

The Transmitter consists of a low power block up-converter (BUC) and a high power amplifier (SSPA.)

The SSPA consists of a Power Supply, RF Amplifier and Cooling System. The power supply provides DC voltages to the RF amplifier and the cooling system. The RF amplifier is capable of providing an output level of 250 – 400W, and contains over temperature shut down and protection circuits. The cooling system fan and heat sink fins together supply and distribute a steady flow of air, preventing the internal electrical components of the SSPA from over-heating. All three components are protected by a shroud, which can be removed easily when replacing the cooling system fan. (Refer to Chapter 4). The SSPA is for outdoor use and is secured onto a mounting frame by two brackets.

2.2 Specifications

Table 1 summarizes the specifications of the WTX-596454_55_56-70-ES-35 250-400 Watt C Band High Power Transmitter Module. For mechanical specifications, refer to the outline drawing, **Error! Reference source not found.** in Appendix A.

Table 1 –Specifications

RF Performance	
Output Frequency WTX-59645x-70-ES-35 WTX-57645x-70-ES-35	 Standard Band: 5.85 to 6.425 GHz Extended Band: 5.725 to 6.425 GHz
IF Frequency WTX-59645x-70-ES-35 WTX-57645x-70-ES-35	 Standard Band: 950 to 1525 MHz Extended Band: 950 to 1650 MHz
Reference Frequency	10 MHz External Reference; (0 ± 5) dBm Input Power Level
Small Signal Gain	70 dB, min over temperature
Gain Flatness (small signal)	± 3 dB, typ. (±4 dB max) over full band ± 2.0 dB, p-p, max. over any 40 MHz
Gain Stability with power (expansion)	0.5 dB, max.

RF Performance	
Output Power WTX-5x6454-70-ES-35 WTX-5x6455-70-ES-35 WTX-5x6456-70-ES-35	 54 dBm (250 W), min at P1dB 55 dBm (320 W), min at P1dB 56 dBm (400 W), min at P1dB
Saturated Output Power WTX-5x6454-70-ES-35 WTX-5x6455-70-ES-35 WTX-5x6456-70-ES-35	 55 dBm (320 W), nominal at PSAT 56 dBm (400 W), nominal at PSAT 56.5 dBm (450 W), nominal at PSAT
3rd Order Intermodulation each	-25 dBc@ two equal signals 3 dB back-off and 5 MHz apart
Phase Noise	-60 dBc/Hz, max. @300 Hz offset of the carrier -70 dBc/Hz, max. @ 1 kHz offset of the carrier -80 dBc/Hz, max. @ 10 kHz offset of the carrier -90 dBc/Hz, max. @ 100 kHz offset of the carrier -100 dBc/Hz, max.@ 1 MHz offset of the carrier
Integrated Phase Noise Error	2.2 degrees, max., from 300 Hz to 1 MHz SSB
Source & Load VSWR	1.5:1 max (operational), infinite at any angle without damage, unconditionally stable
Input Return Loss	-14 dB typical
Output Return Loss	-16 dB max.
Spurious In-band	-50 dBc, max @ P1dB
Spurious Out of Band	-50 dBc, max @ P1dB
Harmonics	-50 dBc, typ. @ P1dB
RF Monitor Port (optional)	-43 dBc, nominal, with a calculation table
Power Consumption	2K Watts, typical
Power Supply	
Input	110/220 VAC, 50/60 Hz
Output	N/A
Cooling	Forced Air
Efficiency	85% nominal
Design Technology	High frequency switching modules
Mechanical Specifications	
Package	Outdoor, weather resistant
Size (overall dimensions	24.5”x 18.5”x 14.6”
Weight	45.5 kg (100 lb) typical
Cooling	Forced Air
Exterior Surface Finish	Painted white
Hardware	Stainless Steel
O-ring	Silicone

RF Performance	
Markings	**Labels permanent and legible**
1	Mitec Name, Part No & Revision Level
2	Serial No.
3	IF Input (J1)
4	RF Output (J2)
5	AC Input (J3)
6	RS-485 (J4)

Environmental	**Operational**	**Storage**
Temperature	-40^0 to 60^0C	-55^0C to 85^0C
Humidity	5% to 95% at 40^0C	5% to 95% at 65^0C
Altitude	10,000 ft AMSL	40,000 ft AMSL
Shock and Vibration	Normal transport and handling	
Wind	100 km/hr	N/A
Drop	N/A	1m in shipping container
Reliability		
MTBF (mean time between failures)	80,000 hours (fan reliability data is not included. Fan must be replaced once every 2 years minimum.	

NOTE

Technical specifications are subject to change without notice.

2.2.1 Controls, Indicators and Connectors

The controls and indicators appear in Table 2.

Table 2 –Controls and Indicators

Controls	**Description**
Externally controlled	Via RS-485 half/full duplex data transmission
Gain	Via RS-485, 20 dB adjustable range, nominal
Mute Control S/W	Via RS-485
Mute In H/W	N/A
Mute In H/W	Contact Closure - to Mute short pin K to pin M
Temperature Compensation	Internally set
Over Temperature Shut Down	82^0 C, var.: -2^0C to $+3^0$C, at case temperature internally set

Indicators	Description
RF Forward Power	Via RS-485
RF Reverse Power	N/A
RF Overdrive	N/A
RF On	N/A
Mute Status	Via RS-485
Over Temperature	Via RS-485
Alarm Summary	TTL Low - Alarm
Alarm Summary	Contact Closure - on Alarm pin N opens from pin T
Alarm Summary	Contact Closure - on Alarm pin P closes from pin T
Temperature Sensor	Via RS-485

2.2.2 General Considerations

The module shall meet all specifications over full bandwidth and under all environmental conditions when terminated with a load of VSWR at 1.5:1 unless otherwise specified. All RF specifications shall be met within five minutes after applying DC power, except gain stability and gain flatness, which shall be met after a warm-up period of twenty minutes. During the warm-up period, the module **MUST NOT** exhibit any alarm or require an RF mute input signal to reset any alarm/fault latches.

2.3 Basic Mechanical Characteristics

2.3.1 External View of the Transmitter Module

The physical external dimensions of the transmitter module are shown in Figure 3 and Table 1. All inputs and outputs are shown in Figure 3.

2.3.2 Connections and Mounting Hardware

The connections require a coaxial cable with an N-type (F-type optional) male connector for the IF Input and waveguide for RF Output. There is also a cylindrical connector on the RF Input side of the SSPA for AC power. The pin assignment for this connector is shown in Appendix B. Four brackets, each with two #1/4 screws, fastens the SSPA and BUC on to the mounting frame for adequate support.

Two U bolts with nuts are supplied to attach the frame to the beam. See section 2.4 below.

2.4 Assembly and Installation

Use the information in this section as a guide to assemble and install the transmitter module.

CAUTION!

Only authorized technical personnel should perform the Installation and proper electrical hookups of the transmitter module.

2.4.1 Lifting the Transmitter Module into Position and Temporary Attachment

The transmitter module weighs approximately 18kg (39.6 lb), which may be handled by a single person. Remove all plastic caps from the connectors. Lift the transmitter module. The transmitter module is now ready for permanent attachment.

2.4.2 Securing the Transmitter Module

Secure the transmitter module on to the mounting frame using the hardware described in section 2.2.2. Attach the proper cable or waveguide for IF input, RF output and AC power to the corresponding connector of the transmitter module. Refer to **Error! Reference source not found.** in Appendix A.

NOTE

*The cylindrical connector is labeled clearly and has different pin layout. Refer to **Error! Reference source not found.**. It is impossible to incorrectly install the mating connectors.*

The SSPA requires a steady flow of air. To provide a sufficient airflow, the SSPA should be properly oriented and mounted with a minimum clearance of 3.0 inches (see Figure 1). Adequate cooling for the SSPA will provide years of top performance.

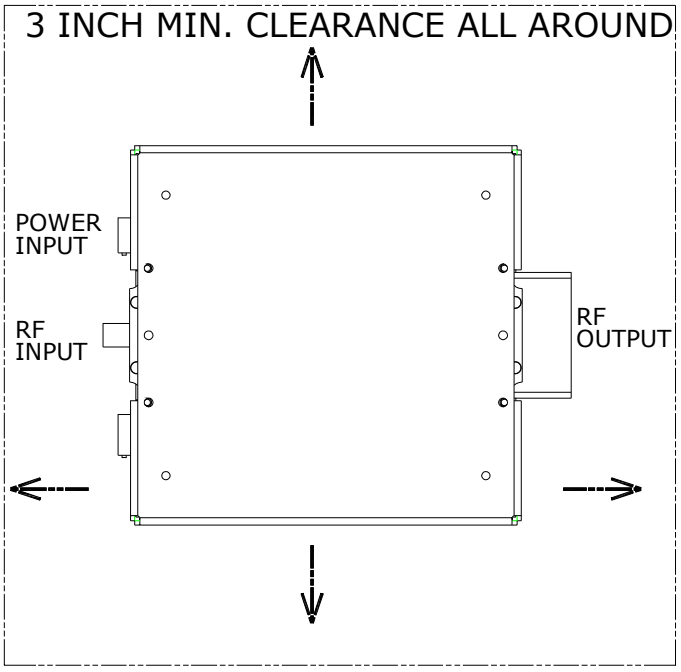

Figure 1 – Recommended Distance for Mounting on the Hub

2.5 Functional Overview

2.5.1 General

This section describes the transmitter module functions in detail. The functional overview explains the RF amplification, protection circuit and power distribution.

Figure 2 block diagram illustrates the transmitter module.

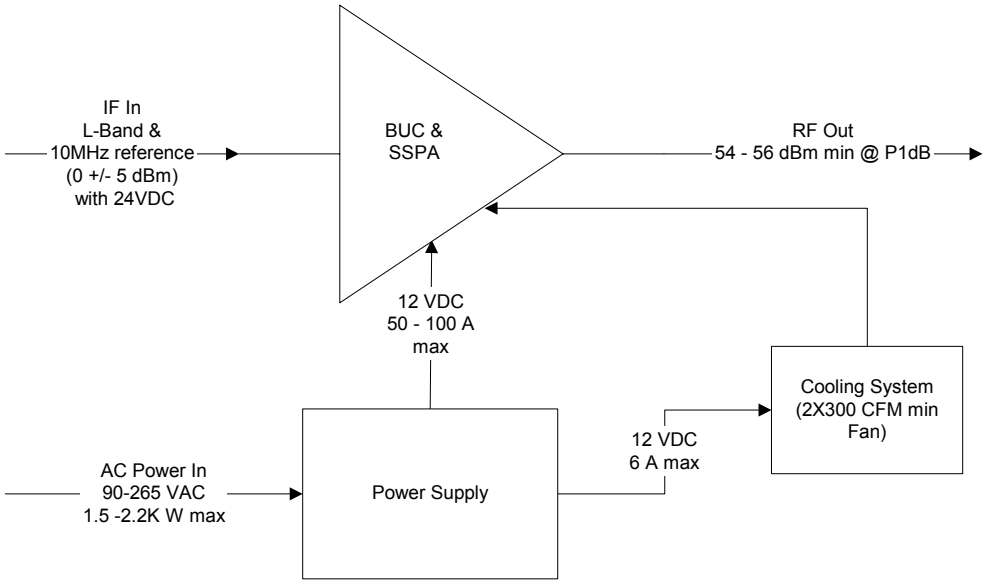

Figure 2 - System Block Diagram

2.5.2 IF/RF Conversion and Amplification

The IF Input signal with a 10MHz reference, 0 ± 5dBm and 24VDC, 2A nominal enters the BUC by a coaxial cable, converted to C-Band by the BUC and goes through an isolator, which provides good VSWR at the input. Under normal operation, the RF amplifier will amplify the RF Input signal level up to a power level of 54 to 56 dBm (250 to 400 Watts CW) P1dB minimum. For small signal gain, the transmitter module is capable of providing a gain of approximately 70 dB.

To achieve the rated output power, GaAs transistors, as well as other microwave components within the RF Amplifier, provide the necessary gain and low insertion loss. The amplified signal is transmitted through waveguide to a satellite up-link system.

2.5.3 Protection and Control

The protection and control circuitry are all within the RF Amplifier.

A control section contains all of the necessary DC power conditioning circuitry to provide the proper bias and sequencing of RF amplifier devices. The protection function within the control section includes the over-temperature shut down.

The SSPA has a temperature sensor on the hot spot of the unit. If the temperature of SSPA hot spot exceeds 85°C, the RF Amplifier Module will shut down until the condition is corrected.

2.5.4 Internal Power Distribution Reference

The transmitter module operates from power source of 24VDC for the BUC and 90 VAC to 265 VAC, 47 Hz to 63 Hz for the SSPA. It will consume approximately 1.5 – 2.2K watts.

The power supply converts the incoming AC voltage into two separate DC voltages. The DC voltages are regulated to ensure isolation and stability. The module provides:

- 12 VDC, 160A maximum to the RF amplifier
- 12 VDC, 6A maximum to the cooling system fan. Refer to **Error! Reference source not found.** in Appendix A.

The power supply is capable of 85% efficiency.

If the input voltage exceeds its maximum value, the power conditioner board will shut down the SSPA until the over voltage condition is corrected. Inrush current will not trip this protection circuit.

2.5.5 Serial Protocol

Appendix D contains the serial protocol document relevant to these products.

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3 Operation

This chapter describes the verification of the operation and control of the transmitter module. It shall be performed by authorized personnel prior to maintenance and/or repair.

3.1 Procedure

Verify that the installation procedure described in Chapter 2 was completed. A complete physical check of the customer's system is suggested.

WARNING!

The output power available at the output waveguide flange is extremely hazardous. Under ***no circumstances*** *should the transmitter be operated without the waveguide feed or a high power load attached. Do not operate this equipment in the presence of flammable gases or fumes. Failure to observe this precaution will result in personal injury. Safe and careful installation of this transmitter will eliminate the possibility of accidents and provide years of top performance.*

Turn ON the power and allow a warm up period of twenty minutes before operating the transmitter module. This will assure stable gain and power. The transmitter module can function with a coupler when a direct measurement of the output power is made.

NOTE

The transmitter module can withstand any source or load VSWR. However, the transmitter module will meet all specification requirements only if the source/load VSWR is sufficient (see Section 2.2).

NOTE

Normal operation is not possible if the antenna feeder VSWR is greater than 1.5:1.

CAUTION!

It is strongly recommended not to exceed -20 dBm maximum IF Input level. The transmitter module will be in deep saturation if overdriven. RF performance will degrade significantly, and proper operation is not possible. This operational condition is the survival mode for the transmitter module. Never exceed the maximum safe IF Input level of -20dBm (0.01W) or permanent damage to the transmitter module may result.

3.2 Interface

The connector interface is described in Table 3.

Table 3 - Connector Interface

Connector Name	Type	Pin #	Signal Name	Description	Parameter
J1 "IF INPUT"	N-Type Female	N/A	IF In	IF Input 24 VDC IN 10 MHz Ref. In	-20 dBm, max 24 VDC, 1.5 Amax 0 to ±5 dBm
J2 "RF OUTPUT"	WR 137G	N/A	RF Out	RF Output	
J3 "AC INPUT"	MS3102R16-10P 3 pins male	A	L	Line	110/220VAC 50 - 60 Hz 2.2KW max.
		B	GND	Ground	
		C	N	Neutral	
J4 "RS-485"	MS3102R20-29S 17 pins female	A	TX+ (output to)	RS-485	RS-485 Interface Half Duplex/ Full Duplex (Configurable)
		B	TX-		
		C	RX+ (input from)		
		D	RX-		
		F	AL_Sum	Summary_Alarm	TTL Low - Alarm
		H	Reserved	Reserved	Reserved
		G	GND	Ground	Signal GND
		L	+12V	+12 VDC Supply	12 VDC
		J	GND	Ground	
		K	M_I	Mute In	To Mute short Pin K to Pin M
		M	M_I_Com	Mute In Common	
		N	AL_Sum_NO	Summary Alarm Normally Open	Pin N Opens From Pin T on Alarm
		P	AL_Sum_NC	Summary Alarm Normally Closed	Pin P Closes to Pin T on Alarm
		T	AL_Sum_Comm	Alarm Common	Floating

4 Maintenance

This chapter contains information on how to maintain, troubleshoot and repair the transmitter module. The transmitter module is extremely reliable, requiring very little preventive maintenance, or repair. Should there be a malfunction, this chapter also contains technical information to help diagnose basic failures.

4.1 Preventive Maintenance

4.1.1 Procedure

WARNING!

Shut down the transmitter module before disassembly and remove all cables and connectors. Failure to observe this precaution may result in personal injury or death. This includes the removal of any RF power originating from other system components.

When the transmitter module is in the hot stand-by mode in a redundant system, switch it to the operation mode at least once every three months. Make sure the fan is running while in operation mode.

When the transmitter module is in the cold stand-by mode in a redundant system, switch it to the operation mode at least once every three months. Make sure the fan is running while in operation mode.

4.1.2 Transmitter Module Cooling System Preventive Maintenance

Preventive maintenance is limited to checking the performance of the transmitter module cooling system. No electrical or mechanical adjustments are required for normal operation.

The fan is the least reliable item in the transmitter module. Wearing of the fan bearings will cause the RPM to drop and will create a higher than average heat-sink temperature. It is recommended to replace the fan after 2 years of operation.

4.1.3 Performance Check

Verify the system is properly set up as per Chapters 2 and 3. The power output at 1 dB compression shall be measured for evaluating the performance of the transmitter module.

It is recommended to measure the following parameters for ensuring that the transmitter module is in good working condition:

- Gain and Gain flatness
- RF load VSWR and RF source VSWR
- Two-Tone Intermodulation Distortion
- Return Loss at connectors J1 and J2 of the TRANSMITTER MODULE

Using a Source and an IF input signal level within the small signal region of the transmitter module, measure the power level at connectors J1 and J2. See **Error! Reference source not found.**. Plot the swept response on a test data sheet. From the plot, determine gain and gain flatness.

With an IF Input signal level within the small signal region of the transmitter module, measure the VSWR (Return Loss) at connectors J1 and J2. See **Error! Reference source not found.**. Plot the swept return loss for both the IF Input and RF Output signals on a test data sheet. From the plot determine the return loss.

From the output power measurements determine P1dB. Record value on a test data sheet.

Measure the Two-tone Intermodulation Suppression using two equal signals separated by 5 MHz. Record value on test data sheet.

4.1.4 Troubleshooting

WARNING!!

Cable connection and disconnection shall be done carefully to avoid physical damage to the cables and connectors, which may cause intermittent problems in the future.

Use Table 4 to quickly isolate a fault within the transmitter module. If the transmitter module is defective, notify mitec and follow the process detailed in section 1.1.2.

Symptom	Action
Fails performance test	Check power source, RF source, cabling and connectors. Check for clogged fan and debris in heat-sink fins. Clean thoroughly. If fan is worn, replace fan. If correct, transmitter module is defective. Return transmitter module to mitec.

Table 4 - Recommended Corrective Actions

4.1.5 Out-of Warranty Repair

A non-warranty and out-of-warranty repair service is available from **mitec** for a nominal charge. The customer is responsible for paying the cost of shipping the SSPA both to and from **mitec** for these repairs.

Appendix A

Drawings & Schematic Diagrams

WTX-576454/55/56-70-ES-35 Outline Drawing

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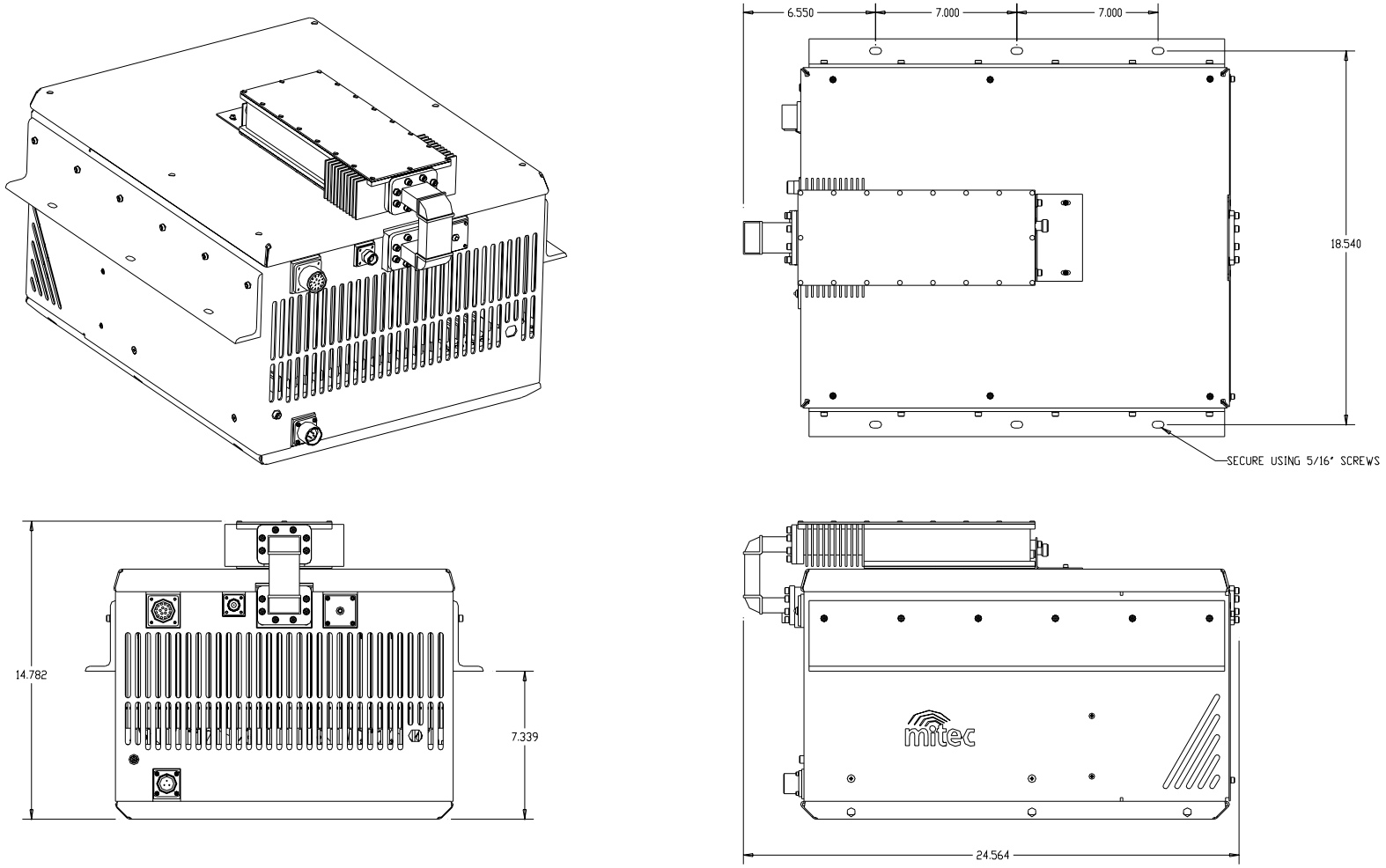

Figure 3 – WTX-576454/55/56-70-ES-35 Outline Drawing

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Appendix B

Bench Test Record

Appendix B contains the bench test record for the product version described herein.

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Appendix C

Spare Parts

Appendix C contains a table of recommended spare parts for on-hand replacement. The following sheet can be copied and used as a fax form to order the required spare parts. Please make sure to include all identifying information to facilitate the processing of your order. The order may also be sent via email or regular mail delivery, at the following address.

Mitec telecom inc.
9000 Trans Canada Blvd.
Pointe Claire, Quebec, Canada
H9R 5Z8

Fax: (514) 694-3814
Email: rmitch@mitectelecom.com

For additional information, please contact our customer service department at:
(514) 694-9000 or 1-800-724-3911

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Mitec Telecom Inc. *Designers and manufacturers of telecom & wireless products* *ISO 9001 Certified*	
Spare Parts Order Form	**WTX-596450_51_52_53-70-ES-35 100-200 Watt C Band High Power Transmitter Module**

From:			
Place By:		**Signature:**	
Telephone:			
Fax		**Email:**	

Part Description	Part Number	Quantity	Unit Price*	Line Total*

* To be completed by **mitec** Sales Department

Fax to: Customer Service (514) 694-3814

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Appendix D

Serial Interface Protocol

Appendix D contains the serial protocol documentation relevant to these products when used in a stand-alone configuration.

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Revision	Date	Change Summary	Approval
0A	22-Apr-2003	Preliminary specification sent to customer.	C. Villeneuve
0B		Document does not exist.	
0C		Document does not exist.	
0D	04-Dec-2003	Extracted protocol specs from technical specs document.	C. Villeneuve
0E	16-Jan-04	Completely revamped the document format. No functional changes made.	C. Villeneuve

Serial Communication Protocol Specification
For
Control Software 3900040-00

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1 Document legend

Text in this document highlighted in grey identifies features which are planned but not implemented yet.

2 Project Overview

This document describes the communications protocol used to communicate with high-power transmitter modules (ODUs) configured with embedded software 3900040-00 when used in a stand-alone configuration.

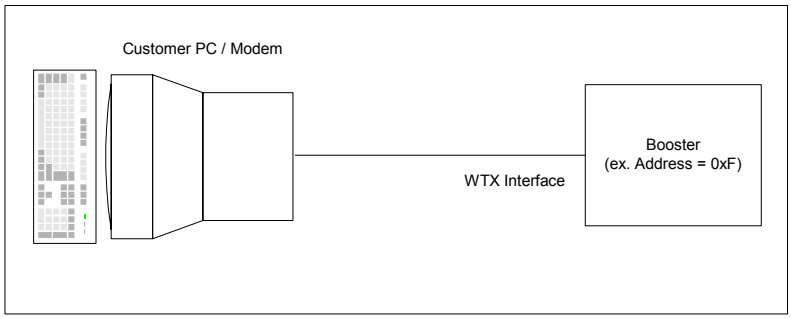


Figure 1) System Block Diagram

If the Booster is configured in a redundant configuration or is connected through a transceiver, then the communications protocol for the redundant kit or transceiver supercedes the present document.

3 Definitions and acronyms

The following terms appear throughout this document:

Controller:	The microprocessor-based card and associated embedded software which handles all communications between the customer interface and the amplifier.
CRC:	Cyclic Redundancy Check
Customer Interface Port:	The interface port through which the device used by the customer will interact with the Transceiver (ie. typically a modem or PC).
Customer Interface Device:	The interface device used by the customer to interact with the Transceiver (ie. typically a modem or PC).
PC:	Personal Computer.
RF:	Radio Frequency.
SCI:	Serial Communications Interface.
WBT:	Wavesat Bias Tee Unit
WTX:	Wavesat Transmitter

4 Scope

This document covers all aspects of the communication protocol which are required for the customer to develop a controlling device (typically a PC application program or modem) to interface with the Mitec product.

5 Serial Communications Link Interface

5.1 Customer Interface Port Configuration

The customer interface port of the controller is configured as follows:

Baud Rate:	19200bps
Data bits:	8
Stop bits:	1
Parity:	None
HW Control	None

5.2 Customer Interface Cable Connections

This software protocol remains the same regardless of the transport medium used (ie RS232, RS485 half duplex or RS485 full duplex). This section defines the wiring required to communicate with the Mitec product.

Note that the pin numbers on both side of the cable are deliberately omitted since these will vary depending on the Mitec product as well as the PC / Modem interface. Please refer to the specific user manuals for pin allocations.

Please refer to the user manual for the Mitec product if unsure of the customer interface transport medium.

For RS232:

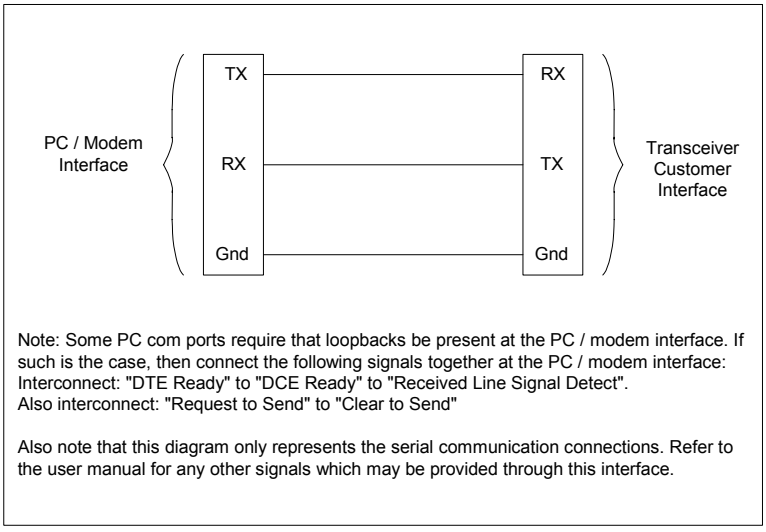

PC / Modem Interface
TX
RX
Gnd
RX
TX
Gnd
Transceiver Customer Interface
Note: Some PC com ports require that loopbacks be present at the PC / modem interface. If such is the case, then connect the following signals together at the PC / modem interface:
Interconnect: "DTE Ready" to "DCE Ready" to "Received Line Signal Detect".
Also interconnect: "Request to Send" to "Clear to Send"
Also note that this diagram only represents the serial communication connections. Refer to the user manual for any other signals which may be provided through this interface.

Figure 2) RS232 Customer Interface Wiring

For RS485 Half Duplex:

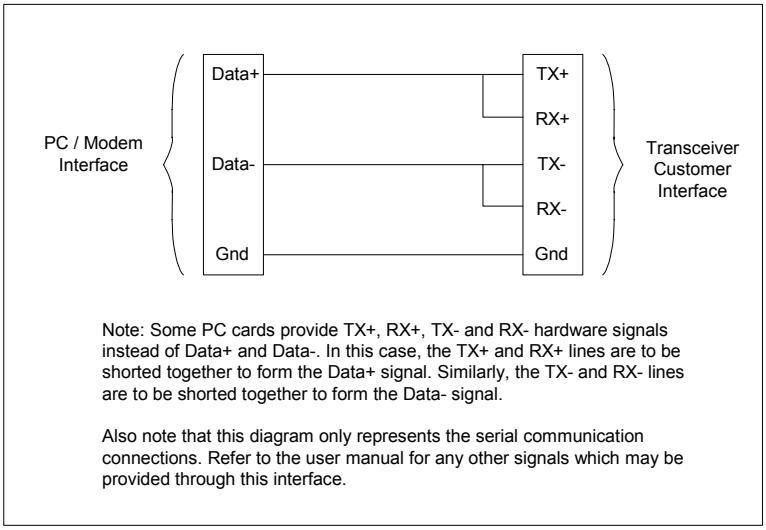

PC / Modem Interface
Data+
Data-
Gnd
TX+
RX+
TX-
RX-
Gnd
Transceiver Customer Interface
Note: Some PC cards provide TX+, RX+, TX- and RX- hardware signals instead of Data+ and Data-. In this case, the TX+ and RX+ lines are to be shorted together to form the Data+ signal. Similarly, the TX- and RX- lines are to be shorted together to form the Data- signal.
Also note that this diagram only represents the serial communication connections. Refer to the user manual for any other signals which may be provided through this interface.

Figure 3) RS485 Half Duplex Customer Interface Wiring

For RS485 Full Duplex (ie RS422):

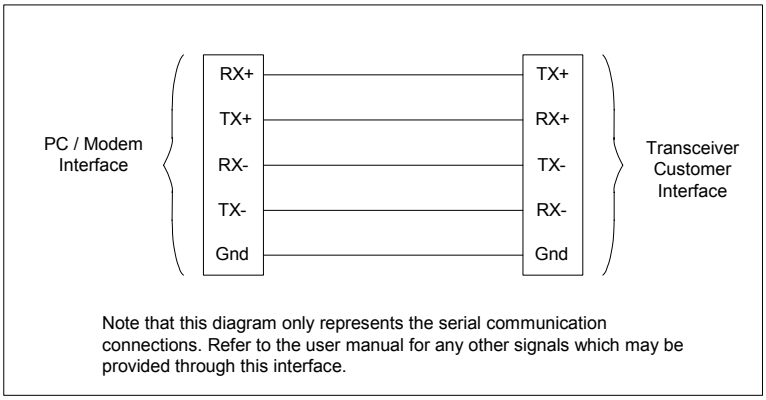


Figure 4) RS485 Full Duplex (ie RS422) Customer Interface Wiring

6 Communication Protocol Framing

6.1 SCI Packet Frame Format

The packets exchanged with the master controller will have the following format (regardless of direction):

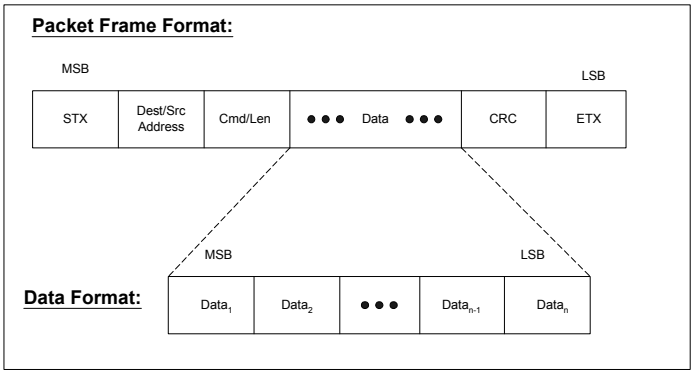


Figure 5) SCI Packet Frame Format

6.1.1 SCI Packet Byte Description

- **STX** is the start transmission byte (defined as 0x7E). This byte is used to determine the start of a packet.

- **Dest/Src Address** contains the destination address in the high nibble and the source address in the low nibble. The destination address is the address of the device which is to process the packet. The source address is the address of the device which sent the packet. Note that the device address of the customer interface device is always = 0x0F.

- **CMD/Len** contains the packet command in the high nibble and the number of bytes in the data portion of the packet in the lower nibble.

  The following commands may be sent by the customer interface device:

GET (command high nibble = 0x0)	Request the current value of a database element.
SET (command high nibble = 0x1)	Set the database element to the specified value.

  The following commands may be returned to the customer interface device:

UPD (command high nibble = 0x8)	Return the current value of a database element.
ACK (command high nibble = 0xE)	Acknowledge a received packet.
NACK (command high nibble = 0xF)	Reject a received packet (Not ACKnowledge).

- **$Data_1$ - $Data_n$** contains the packet payload. The value of the data bytes is specific to the command and will be covered in following sections.

- **CRC** is the cyclic redundancy check and is calculated by performing a byte-wise exclusive OR of the Dest/Src address byte, Cmd/Len byte and all data bytes. A bit-wise inversion is then applied to the CRC before being inserted into the packet.

- **ETX** is the end transmission byte (defined as 0x7F). This byte is used to determine the end of a packet.

6.1.2 Default Address Values

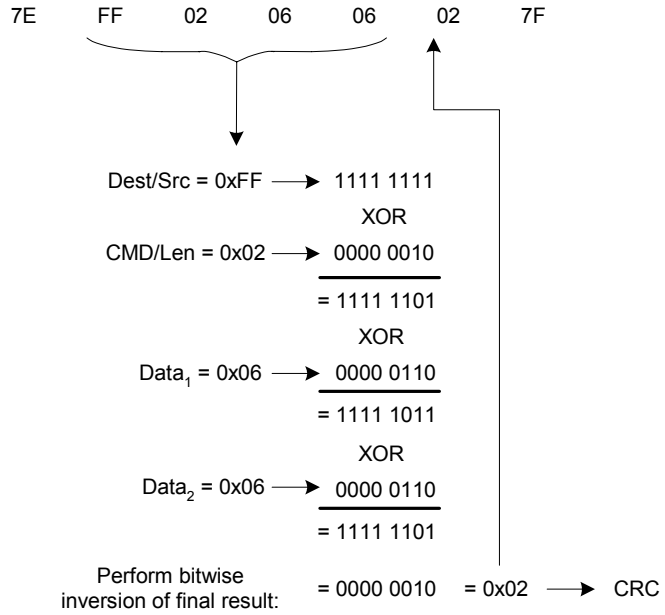
The customer interface device must always be assigned address 0xF.

The Transceiver device address is factory defaulted to 0xF. It may be set by the customer using the SET Transceiver Address command (refer to SET Control Command List).

The Booster device address is factory defaulted to 0xE. It may be set by the customer using the SET Booster Address command (refer to SET Control Command List).

6.1.3 CRC Calculation Example

To send a command to read the temperature (database element = 0x0606) from the Booster (device address 0x0F), the command is:



6.1.4 Command / Reply Packet Sequencing

The Transceiver will never send a packet to the customer interface device unless a command is received. In other words, the Transceiver will not speak unless spoken to.

7 Command List

7.1 Default Reply Packet Format

This section identifies the packet format the ACK (Acknowledge) and NACK (Not acknowledge) replies which may be sent to the customer interface device in response to a received command.

NOTE: The packets shown in the list below are based on the assumption that the Booster device address is set to 0xF. To modify the commands for different addresses, the Dest/Src byte and the CRC byte will have to change in all packets.

Reply	Packet Format	Explanation	Interpretation	Examples
ACK (Acknowledge)	7E FX E0 ZZ 7F	Acknowledge that the received packet was properly processed.	X = Device address of the packet source device. ZZ = CRC.	1) reply: 7E FF E0 E0 7F (ACK reply sent from the Booster)
NACK (Not Acknowledge)	7E FX F1 YY ZZ 7F	Indicate that a problem was encountered with the received packet.	X = Device address of the packet source device. YY = Error code (03 = Incorrect CRC 18 = Unrecognized command 30 = Set command attempted on a restricted database element) ZZ = CRC.	1) reply: 7E FF F1 03 F2 7F (NACK reply sent from the Booster for an invalid CRC) 2) reply: 7E FF F1 18 E9 7F (NACK reply sent from the Booster for an unrecognized command).

7.2 GET Status Command List

This section identifies the list of commands available to query any unit for status information.

NOTE: The packets shown in the list below are based on the assumption that the Booster device address is set to 0xF. To modify the commands for different addresses, the Dest/Src byte and the CRC byte will have to change in all packets.

Command	Packet Format	Explanation	Possible Replies	Interpretation	Examples
Get Booster Temperature	7E FF 02 06 06 02 7F	Query booster for current temperature	**Update Booster Temp:** 7E FF 84 06 06 TT TT ZZ 7F	TT TT = Booster temp in °C + 273. ZZ = CRC.	1) cmd: 7E FF 02 06 06 02 7F reply: 7E FF 84 06 06 01 02 87 7F (Temp = 0x0102 = 0d258 – 273 = -15°C) 2) cmd: 7E FF 02 06 06 02 7F reply: 7E FF 84 06 06 01 34 B1 7F (Temp = 0x0134 = 0d308 – 273 = +35°C)
			NACK	Refer to 7.1.	
Get Booster Temperature Sensor Voltage	7E FF 02 2F FF D2 7F	Query booster for current temperature sensor voltage (Note: This command is to be used if a more accurate temperature reading is required than the result of the "Get Booster Temperature" command.)	**Update Booster Temp Sensor:** 7E FF 84 2F FF VV VV ZZ 7F	VV VV = Booster temp sensor voltage from 0V (0x0000) to +5V (0x03FF). The conversion formula is: Temp = (Voltage x 0.4883) – 273. ZZ = CRC.	1) cmd: 7E FF 02 2F FF D2 7F reply: 7E FF 84 2F FF 02 06 50 7F (Voltage = 0x0206 = 0d518. Temp = (518 x 0.4883) – 273 = -20.1°C) 2) cmd: 7E FF 02 2F FF D2 7F reply: 7E FF 84 2F FF 02 76 20 7F (Voltage = 0x0276 = 0d630. Temp = (630 x 0.4883) – 273 = +34.6°C)
			NACK	Refer to 7.1.	
Get Booster Output Power	7E FF 02 17 FF EA 7F	Query booster for current output power	**Update Booster Output Power:** 7E FF 84 17 FF PP PP ZZ 7F	PP PP = Output power in 10 x dBm. ZZ = CRC.	1) cmd: 7E FF 02 17 FF EA 7F reply: 7E FF 84 17 FF 01 2C 41 7F (Power = 0x012C = 0d300 = 30.0dBm.) 2) cmd: 7E FF 02 17 FF EA 7F reply: 7E FF 84 17 FF 01 A0 CD 7F (Power = 0x01A0 = 0d416 = 41.6dBm.)
			NACK	Refer to 7.1.	
Get Booster Gain (if applicable)	7E FF 02 18 FF E5 7F	Query booster for current gain	**Update Booster Gain:** 7E FF 84 18 FF GG GG ZZ 7F	GG GG = Gain in 10 x dB. ZZ = CRC.	1) cmd: 7E FF 02 18 FF E5 7F reply: 7E FF 84 18 FF 02 08 69 7F (Gain = 0x0208 = 0d520 = 52.0dB.) 2) cmd: 7E FF 02 18 FF E5 7F reply: 7E FF 84 18 FF 01 95 F7 7F (Gain = 0x0195 = 0d405 = 40.5dB.)
			NACK	Refer to 7.1.	

Command	Packet Format	Explanation	Possible Replies	Interpretation	Examples
Get Mute Status	7E FF 02 06 01 05 7F	Query booster for mute status	**Update Mute Status:** 7E FF 84 06 01 00 MM ZZ 7F	MM = Mute status (0 = enabled; 1 = muted) ZZ = CRC.	1) cmd: 7E FF 02 06 01 05 7F reply: 7E FF 84 06 01 00 00 83 7F (Booster is enabled.) 2) cmd: 7E FF 02 06 01 05 7F reply: 7E FF 84 06 01 00 01 82 7F (Booster is muted.)
			NACK	Refer to 7.1.	
Get IF Frequency	7E FF 02 16 FF EB 7F	Query transceiver for IF frequency	**Update IF Frequency:** 7E FF 84 16 FF XX XX ZZ 7F	XX XX = System IF frequency in MHz. ZZ = CRC.	1) cmd: 7E FF 02 16 FF EB 7F reply: 7E FF 84 16 FF 03 B6 D8 7F (IF frequency set to 0x03B6 = 0d950 = 950 MHz)
			NACK	Refer to 7.1.	
Get Booster SW Version Base number (MSB)	7E FF 02 05 FC FB 7F	Query booster for SW version base MSB	**Update SW Version Base MSB:** 7E FF 84 05 FC 39 00 44 7F	SW version base number MSB is always 0x3900.	1) cmd: 7E FF 02 05 FC FB 7F reply: 7E FF 84 05 FC 39 00 44 7F cmd: 7E FF 02 05 FD FA 7F reply: 7E FF 84 05 FD 00 40 3C 7F cmd: 7E FF 02 05 FE F9 7F reply: 7E FF 84 05 FE 00 00 7F 7F cmd: 7E FF 02 05 FF F8 7F reply: 7E FF 84 05 FF 30 41 0F 7F The resulting software version is: 3900040-00-R0A
			NACK	Refer to 7.1.	
Get Booster SW Version Base number (LSB)	7E FF 02 05 FD FA 7F	Query booster for SW version base LSB	**Update SW Version Base LSB:** 7E FF 84 05 FD XX XX ZZ 7F	XX XX = SW version base number (LSB). ZZ = CRC.	
			NACK	Refer to 7.1.	
Get Booster SW Version Configuration	7E FF 02 05 FE F9 7F	Query booster for SW version configuration	**Update SW Version Config:** 7E FF 84 05 FE 00 XX ZZ 7F	XX = SW version configuration. ZZ = CRC.	
			NACK	Refer to 7.1.	
Get Booster SW Version Revision	7E FF 02 05 FF F8 7F	Query booster for SW version revision	**Update SW Version revision:** 7E FF 84 05 FF RR RR ZZ 7F	RR RR = SW version revision represented as two ASCII characters. ZZ = CRC.	
			NACK	Refer to 7.1.	
Get Booster Device Address	7E FF 02 03 04 05 7F	Query booster for device address	**Update booster device address:** 7E FF 84 03 04 00 XX ZZ 7F	XX = Booster device address. ZZ = CRC.	1) cmd: 7E FF 02 03 04 05 7F reply: 7E FF 84 03 04 00 0A 89 7F (Booster device address = 0xA) 2) cmd: 7E FF 02 03 04 05 7F reply: 7E FF 84 03 04 00 0E 8D 7F (Booster device address = 0xE)
			NACK	Refer to 7.1.	

7.3 GET Alarms Command List

This section identifies the list of commands available to query any unit for alarm information.

NOTE: The packets shown in the list below are based on the assumption that the Booster device address is set to 0xF. To modify the commands for different addresses, the Dest/Src byte and the CRC byte will have to change in all packets.

Command	Packet Format	Explanation	Possible Replies	Interpretation	Examples
Get Booster Over Temperature Alarm	7E FF 02 00 02 00 7F	Query booster for over temperature alarm	**Update booster over temperature alarm:** 7E FF 84 00 02 00 XX ZZ 7F	XX = Alarm state (0 = no alarm; 1 = alarm) ZZ = CRC.	1) cmd: 7E FF 02 00 02 00 7F reply: 7E FF 84 00 02 00 01 87 7F (Booster over temp alarm is raised) 2) cmd: 7E FF 02 00 02 00 7F reply: 7E FF 84 00 02 00 00 86 7F (Booster over temp alarm is clear)
			NACK	Refer to 7.1.	
Get Booster Low Power Alarm (if applicable)	7E FF 02 00 05 07 7F	Query booster for low power alarm	**Update booster low power alarm:** 7E FF 84 00 05 00 XX ZZ 7F	XX = Alarm state (0 = no alarm; 1 = alarm) ZZ = CRC.	1) cmd: 7E FF 02 00 05 07 7F reply: 7E FF 84 00 05 00 01 80 7F (Booster low power alarm is raised) 2) cmd: 7E FF 02 00 05 07 7F reply: 7E FF 84 00 05 00 00 81 7F (Booster low power alarm is clear)
			NACK	Refer to 7.1.	
Get Booster Summary Alarm	7E FF 02 00 0F 0D 7F	Query booster for summary alarm	**Update booster summary alarm:** 7E FF 84 00 0F 00 XX ZZ 7F	XX = Alarm state (0 = no alarm; 1 = alarm) ZZ = CRC.	1) cmd: 7E FF 02 00 0F 0D 7F reply: 7E FF 84 00 0F 00 01 8A 7F (Booster summary alarm is raised) 2) cmd: 7E FF 02 00 0F 0D 7F reply: 7E FF 84 00 0F 00 00 8B 7F (Booster summary alarm is clear)
			NACK	Refer to 7.1.	

7.4 SET Control Command List

This section identifies the list of commands available to set control parameters any unit.

NOTE: The packets shown in the list below are based on the assumption that the Booster device address is set to 0xF. To modify the commands for different addresses, the Dest/Src byte and the CRC byte will have to change in all packets.

Command	Packet Format	Explanation	Possible Replies	Interpretation	Examples
Set Mute Control	7E FF 14 13 01 00 MM ZZ 7F	Mute / Unmute the up link. MM = Mute control (1 = Mute; 0 = enable) ZZ = CRC	**ACK**	Refer to 7.1.	1) cmd: 7E FF 14 13 01 00 01 07 7F reply: ACK (Mute up link) 2) cmd: 7E FF 14 13 01 00 00 06 7F reply: ACK (Enable up link)
			NACK	Refer to 7.1.	
Set IF Frequency	7E FF 14 16 FF XX XX ZZ 7F	Set up link frequency XX XX = Frequency in MHz. ZZ = CRC	**ACK**	Refer to 7.1.	1) cmd: 7E FF 14 16 FF 03 B6 48 7F reply: ACK (Set IF frequency to 950 MHz = 0x3B6) 2) cmd: 7E FF 14 16 FF 04 33 CA 7F reply: ACK (Set IF frequency to 1075 MHz = 0x433) 3) cmd: 7E FF 14 16 FF 04 B0 49 7F reply: ACK (Set IF frequency to 1200 MHz = 0x4B0) 4) cmd: 7E FF 14 16 FF 05 2D D5 7F reply: ACK (Set IF frequency to 1325 MHz = 0x52D) 5) cmd: 7E FF 14 16 FF 05 AA 52 7F reply: ACK (Set IF frequency to 1450 MHz = 0x5AA)
			NACK	Refer to 7.1.	
Set Booster Device Address	7E FF 14 03 04 00 XX ZZ 7F	Set booster device address (0 ≤ address ≤ 0xE)	**ACK**	Refer to 7.1.	1) cmd: 7E FF 14 03 04 00 0A 19 7F reply: ACK (Set Booster device address to 0xA) 2) cmd: 7E FF 14 03 04 00 0E 1D 7F reply: ACK (Set Booster device address to 0xE)
			NACK	Refer to 7.1.	

8 Appendix I: Troubleshooting Guide

Problem	Possible Remedies
No response at all from Booster	1) Ensure the cable assembly is wired properly (refer to 5.2Customer Interface Cable Connections) and that it is properly connected between the transceiver customer interface port and the customer device. 2) Verify that the com port parameters are as specified in 5.1Customer Interface Port Configuration. 3) Confirm that the customer interface cable is connected to the correct PC com port. 4) Ensure that there are no other applications executing on the same com port. 5) If the transport medium is RS232, then connect the loopbacks identified in the note in Figure 2) RS232 Customer Interface Wiring. 6) If using a Booster address other than 0xF, then send a "GET Booster Device Address" command to destination address 0xF. The reply will contain the current booster address. Note that the booster will respond to all commands received with destination address 0xF. 7) If the transport medium is RS485 half duplex, note that some PC cards require software control of the RS485 transmit and receive buffer enable lines. The software in the customer device may need to coordinate the enabling /disabling of these buffers. 8) Ensure the booster is powered on.
Reply packet is incomplete.	1) If software control of the transmit and receive buffer enable lines is required (RS485 half duplex), then it is possible that the timing between the transition needs to be adjusted.

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